

This Page Is Inserted by IFW Operations
and is not a part of the Official Record

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images may include (but are not limited to):

- BLACK BORDERS
- TEXT CUT OFF AT TOP, BOTTOM OR SIDES
- FADED TEXT
- ILLEGIBLE TEXT
- SKEWED/SLANTED IMAGES
- COLORED PHOTOS
- BLACK OR VERY BLACK AND WHITE DARK PHOTOS
- GRAY SCALE DOCUMENTS

IMAGES ARE BEST AVAILABLE COPY.

**As rescanning documents *will not* correct images,
please do not report the images to the
Image Problem Mailbox.**

PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

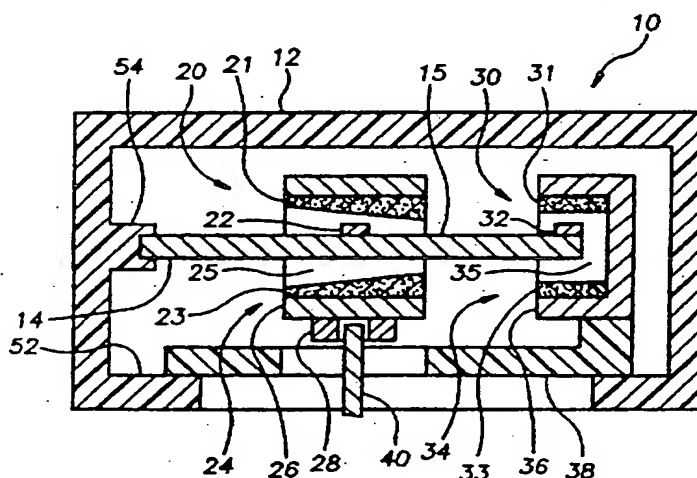


AK

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁶ : G01R		A2	(11) International Publication Number: WO 97/16736
			(43) International Publication Date: 9 May 1997 (09.05.97)
(21) International Application Number: PCT/US96/17255		(81) Designated States: AU, BR, CA, JP, MX, US, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).	
(22) International Filing Date: 18 October 1996 (18.10.96)			
(30) Priority Data: 60/005,770 20 October 1995 (20.10.95) US		Published Without international search report and to be republished upon receipt of that report.	
(71) Applicant (for all designated States except US): CTS COR- PORATION [US/US]; Mr. Michael W. Starkweather, 905 West Boulevard North Elkhart, IN 46514 (US).			
(72) Inventors; and (75) Inventors/Applicants (for US only): OLSON, Thomas, R. [US/US]; 1198 N 450 E, Chesterton, IN 46304 (US). SHRIVER, Bret, W. [US/US]; 5401 Osage Lake Drive #3-B, Mishawaka, IN 46545 (US). ZDANYIS, John, Jr. [US/US]; 26819 Bridgewater Court, Elkhart, IN 46514 (US). NONNENMACHER, Ronald, C. [US/US]; 1617 Locust #203, Elkhart, IN 46514 (US). JARRARD, Craig, A. [US/US]; 611 Spring Arbor Drive, Middlebury, IN 46540 (US). WHITE, James, E. [US/US]; 1721 Sunfish Drive, Warsaw, IN 46580 (US). McCURLEY, Jeffrey, L. [US/US]; 70052 Arbola Drive, White Pigeon, MI 49099 (US).			
(74) Agent: STARKWEATHER, Michael, W.; CTS Corporation, 905 West Boulevard North, Elkhart, IN 46514 (US).			

(54) Title: A TWO AXES LINEAR POSITION SENSOR



(57) Abstract

A dual-axes position sensor (10) having an outer housing (12), an actuator (40), a linear Hall effect sensor assembly (20) for detecting position changes along a first (y) axis, and a linear Hall effect sensor assembly (30) for detecting position changes along a second (x) axis is disclosed. The housing (12) is preferably made out of a non-magnetic material such as plastic. Actuator (40) is rod shaped and coupled to a movable device or shaft (not shown) that is to have its position sensed. The linear Hall effect sensor assembly (20) is unattachably positioned to set on lip (52) of the housing (12), and includes a magnetically conducting pole piece (26), a magnet assembly (24) comprising an upper magnet (21) and a lower magnet (23) that are separated by an air gap (25). Magnet assembly (24) and pole piece (26) are positioned around a Hall sensor device support (14) in a "U" shaped configuration or form. Hall sensor device support (14) is fixedly attached to housing (12) via attachment area (54). Linear Hall effect sensor assembly (20) also includes a positionally fixed Hall effect sensor element (22) attached to Hall sensor device support (14) on surface (15). Linear Hall effect sensor assembly (30) is positioned approximately 90 degrees from and to linear Hall effect sensor assembly (20).

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AM	Armenia	GB	United Kingdom	MW	Malawi
AT	Austria	GE	Georgia	MX	Mexico
AU	Australia	GN	Guinea	NE	Niger
BB	Barbados	GR	Greece	NL	Netherlands
BE	Belgium	HU	Hungary	NO	Norway
BF	Burkina Faso	IE	Ireland	NZ	New Zealand
BG	Bulgaria	IT	Italy	PL	Poland
BJ	Benin	JP	Japan	PT	Portugal
BR	Brazil	KE	Kenya	RO	Romania
BY	Belarus	KG	Kyrgyzstan	RU	Russian Federation
CA	Canada	KP	Democratic People's Republic of Korea	SD	Sudan
CF	Central African Republic	KR	Republic of Korea	SE	Sweden
CG	Congo	KZ	Kazakhstan	SG	Singapore
CH	Switzerland	LI	Liechtenstein	SI	Slovenia
CI	Côte d'Ivoire	LK	Sri Lanka	SK	Slovakia
CM	Cameroon	LR	Liberia	SN	Senegal
CN	China	LT	Lithuania	SZ	Swaziland
CS	Czechoslovakia	LU	Luxembourg	TD	Chad
CZ	Czech Republic	LV	Latvia	TG	Togo
DE	Germany	MC	Monaco	TJ	Tajikistan
DK	Denmark	MD	Republic of Moldova	TT	Trinidad and Tobago
EE	Estonia	MG	Madagascar	UA	Ukraine
ES	Spain	ML	Mali	UG	Uganda
FI	Finland	MN	Mongolia	US	United States of America
FR	France	MR	Mauritania	UZ	Uzbekistan
GA	Gabon			VN	Viet Nam

TITLE: A TWO AXES LINEAR POSITION SENSOR**BACKGROUND OF THE INVENTION****5 1. TECHNICAL FIELD**

This invention relates to a Hall effect position sensor for determining linear position changes along two different axes. The sensor can be used for a variety of applications including a position sensor for a manual shifter.

10 2. BACKGROUND ART

In recent years, many designers of positional sensing equipment have been designing a new breed of sensors based upon the general theories of magnetics. For example, the automotive industry has been in the process of converting the control system of the standard internal combustion engine to a system that can be controlled by a computer that receives input signals from mechanical and electrical systems using hall effect positional sensors.

Examples of patents related to the present invention are as follows, and each patent is herein incorporated by reference for supporting teachings:

20 U.S. patent no. 5,369,361 is a position detecting device using a hall sensor. The device comprises a Hall IC, a magnet, and a back yoke. The Hall IC is moved in a space above the magnet, the position can be detected based upon the change in flux density between the poles of the magnet.

25 U.S. patent no. 5,365,791, is a signal generator for generating an electrical signal that varies according to movement of an actuating member includes a plunger slidable mounted within a housing that carries a pair of permanent magnets for generating a magnetic field to be applied to a Hall effect generator. U.S. patent no. 4,958,615, is a signal generator that has a Hall effect sensor and a magnet disposed inside a distributor housing.

30 U.S. patent no. 4,928,089, is an encoder for a wheel that uses a linear Hall effect sensor and magnet mounted on a non-ferrous metal shaft.

U.S. patent no. 4,703,261, is a measuring system for a gear measuring feeler that has a Hall effect sensor elements arranged in opposing relationship to each other in the magnetic field.

U.S. patent no. 3,473,109 is a position sensor utilizing a Hall generator.
5 A pair of permanent magnets are co-planarly positioned with a pair of opposite poles abutting each other.

The foregoing patents reflect the state of the art of which the applicant is aware and are tendered with the view toward discharging applicant's acknowledged duty of candor in disclosing information that may be pertinent in
10 the examination of this application. It is respectfully stipulated, however, that none of these patents teach or render obvious, singly or when considered in combination, applicant's claimed invention.

SUMMARY OF THE INVENTION

15 It is a feature of the invention to provide a Hall effect position sensor for determining linear position changes along two different axes.

An additional feature of the invention is to provide two Hall effect sensors. The first sensor detects any positional changes along the length of a first axis (y
20 direction) of linear motion and a second sensor detects any positional changes along the length of a second axis (x direction) of linear motion.

The invention resides not in any one of these features per se, but rather in the particular combination of all of them herein disclosed and claimed, and it is distinguished from the prior art by this combination of structures for the
25 functions specified.

There has thus been outlined, rather broadly, the more important features of the invention so the detailed description thereof that follows may be better understood, and so the present contribution to the art may be better appreciated. It is important, therefore, that the claims are regarded as including such
30 equivalent constructions since they do not depart from the spirit and scope of the present invention.

The abstract is neither intended to define the invention of the application, which is measured by the claims, neither is it intended to be limiting as to the scope of the invention in any way.

Other features of the present invention will become more clear from the following detailed description of the invention, taken with the accompanying drawings and claims, or may be learned by the practice of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cross sectional view of an embodiment of the invention taken along line a-a of FIG. 2.

FIG. 2 is a sectional view of the embodiment of FIG. 1 with the housing removed.

FIG. 3 is an exploded perspective view of a preferred embodiment.

FIG. 4 is a cross sectional view of the preferred embodiment of FIG. 3.

It is noted that the drawings of the invention are not to scale. The drawings are merely schematic representations, not intended to portray specific parameters of the invention. The drawings are intended to depict only typical embodiments of the invention, and therefore should not be considered as limiting the scope of the invention. The invention will be described with additional specificity and detail by the accompanying drawings. In the drawings, like numbering represents like elements between the drawings.

DISCLOSURE OF THE INVENTION

The present invention provides a Hall effect position sensor for determining linear position changes along two different axes. Regarding FIG. 1 and FIG. 2, there is a dual axes position sensor 10 having an outer housing 12, an actuator 40, a linear Hall effect sensor assembly 20 for detecting position changes along a first (y) axis, and a linear Hall effect sensor assembly 30 for

detecting position changes along a second (x) axis. The housing 12 is preferably made out of a non-magnetic material such as plastic. The actuator 40 is rod shaped and coupled to a movable device, body, or shaft (not shown) that is to have its position sensed. The linear Hall effect sensor assembly 20 is

5 unattachably positioned to set on lip 52 of housing 12, and includes a magnetically conducting pole piece 26, a magnet assembly 24 that comprises an upper magnet 21 and a lower magnet 23 that are separated by an air gap 25. Air gap 25 changes width along the length of pole piece 26 as the thickness of magnet assembly 24 varies. Magnet assembly 24 may be insert molded to pole
10 piece 26 or molded separately and glued in place. Pole piece 26 is attached to a slide 28 which slidably sits on top of slide 38. Slide 28 has a longitudinal slot 29 capable of receiving actuator 40 (scotch-yoke configuration). Magnets assembly 24 and pole piece 26 are positioned around a Hall sensor device support 14 in a "U" shaped configuration or form. Hall sensor device support 14
15 is fixedly attached to housing 12 via attachment area 54. A positionally fixed Hall effect sensor element 22 attached to Hall device support 14 on surface 15.

Linear Hall effect sensor assembly 30, positioned approximately 90 degrees from linear Hall effect sensor assembly 20, likewise includes a
20 magnetically conductive pole piece 36 and a magnet assembly 34 that comprises an upper magnet 31 and a lower magnet 33 that are separated by an air gap 35. Pole piece 36 is attached to a slide 38 which slidably sits on lip 52 of housing 12. Slide 38 has a longitudinal slot 39 capable of receiving actuator 40 (scotch-yoke configuration). Magnets assembly 34 and pole piece 26 are positioned
25 around the Hall sensor device support 14 in a "U" shaped configuration or form. A positionally fixed Hall effect sensor element 32 attached to Hall device support 14 on surface 15.

In operation, the dual-axes position sensor 10 will sense linear positioning along two different axes (y and x) of a body (not shown) that is coupled to
30 actuator 40. In particular, when the body is moved in a direction perpendicular to slide 28, linear Hall effect sensor assembly 20 will determine the exact

position of the body along the y-axis. The position detection is accomplished by actuator 40 pushing slide 28 and correspondingly both magnet assembly 24 and pole piece 26 in the same direction. As magnet assembly 24 is moved, the magnet thickness and magnetic flux density (B_x) surrounding Hall effect sensor element 22 varies and is detected. Hall effect sensor element 22 produces a voltage signal based on the magnetic flux density, and the voltage signal is then amplified to provide a measurable signal that can be monitored by a control module (not shown). When the actuator is only moved in a direction along the y-axis, there is no change in flux density detected by Hall effect sensor element 32 because the actuator moves along slot 39 and does not push slide 38.

Alternatively, if actuator 40 is moved in a direction along the x-axis, linear Hall effect sensor assembly 30 will operate in a manner similar to linear Hall effect sensor assembly 20 in detecting position changes along the x-axis. Of course, if actuator 40 is moved along a vector that does not correspond exclusively to either the x or y axis, then linear Hall effect sensor assembly 20 will determine the y component of the vector, and linear Hall effect assembly 30 will determine the x component of the vector.

BEST MODE FOR CARRYING OUT THE INVENTION

Referring to FIG. 3, there is an exploded perspective view of an exemplary application of the preferred embodiment of the invention for potentially sensing the position of a manual shift transmission (not shown). In addition to the previously discussed elements of the drawing, the dual-axes position sensor 10 includes lip 56 for slide (slide rack) 28 to traverse along. In this embodiment, slide 28 slidably sits on a lip 56 of housing 12 instead of on top of slide 38. A connector 48 is shown for providing electrical connection from dual-axes position sensor 10 to a vehicle control module (not shown). Hall sensor device support 14 includes a substrate with electrical components mounted thereon. Housing 12 also includes a cover 16 and a retainer piece 44 to hold actuator 40 in place using shoulder 60. Retainer piece 44 can be made from any suitable material

including metal or plastic. Gasket 46 is used in mounting dual-axes sensor 10 to a manual shift transmission (not shown).

In reference to FIG. 4, there is illustrated a cross sectional view of an exemplary application of the preferred embodiment depicted in FIG. 3. In FIG. 4 the Hall sensor device support 14 is shown wire bonded 50 to connector 48. This view further includes a transmission shift rod 64 that is located in a shift tower mechanism (not shown), and which is coupled to actuator 40 using a ball 66 and socket 62 configuration. Dual-axis position sensor 10 can monitor both the axial and rotational travel of the shift rod using this ball 62 and socket 66 coupling. If transmission shift rod is pushed in the y-axis direction, actuator 40 will also move in the y-axis direction and the movement will be detected by linear Hall effect sensor assembly 20. Furthermore, if transmission shift rod 64 is rotated about its axis 68, actuator 40 will move along the x-axis, and linear Hall effect sensor assembly 30 will detect the movement.

Remarks About the Preferred Embodiment

One of ordinary skill in the art of designing and using hall effect position detecting sensors will realize many advantages from using the preferred embodiment. As illustrated in FIG 4, it is possible to couple the actuator to a stick shift of a vehicle to sense the position of the stick shift in both the x and y axis. A skilled artisan will also realize that the hall sensors are fixed relative to the motion of the related combination of the two magnets and connecting pole piece. Additionally, it is well understood that the sensors are electrically coupled to appropriate circuitry for analyzing the positional signals generated therefrom.

I have received another fax from Scotland regarding the AMP Z-pack matter. It indicates an urgency and has copied both Jim Hufford and Ian Archer, but not you. I believe we need to talk sooner than later regarding this Z-pack AMP license initiation subject. I will be out of the office until Monday, October 28.

Could you be available for a short telephone call around 10 a.m.? If not, could you notify my secretary of an alternative time for us to discuss this matter.

Variations of the Preferred Embodiment

5

Although the illustrated embodiments discuss the arrangement of the two sensors relative to each other, one skilled in the art will realize that the preferred embodiment would work with most any arrangement. For example, the two sensors could be positionally switched or placed at different angles to one another. Additionally, although the preferred embodiment discusses the use of two magnets and one pole piece per sensor with the Hall effect sensor positioned therebetween, a skilled artisan could probably use most any known hall effect based sensor design. It is contemplated to design the sensor assembly so that the magnets are stationary and the actuator moves the Hall sensor devices 20 and 30 instead. Additionally, there are many other ways to vary the intensity of the magnetic flux field other than using magnets having different thicknesses. The magnets could be of uniform thickness but positionally slanted to create a variable air gap, or they can be magnetized to varying magnetic flux strengths along their length. The poles in the magnets can also be oriented in a number of different ways so that the Hall sensor device will be able to detect movement.

15

20

25

While the invention has been taught with specific reference to these embodiments, someone skilled in the art will recognize that changes can be made in form and detail without departing from the spirit and the scope of the invention. The described embodiments are to be considered in all respects only as illustrative and not restrictive. The scope of the invention is, therefore, indicated by the appended claims rather than by the description. All changes that come within the meaning and range of equivalency of the claims are to be embraced within their scope.

What is claimed and desired to be secured by Patent is:

- 1 1. A sensor for determining linear position of a movable body along two
2 different axes, comprising:
 - 3 a) a housing;
 - 4 b) an actuator coupled to the movable body;
 - 5 c) first linear sensing means, positioned within the housing and coupled to the
6 actuator, for sensing the linear position of the actuator along a first axis;
7 and
 - 8 d) second linear sensing means, positioned within the housing and coupled to
9 the actuator, for sensing the linear position of the actuator along a second
10 axis being different from the first axis.
2. The sensor of claim 1, wherein the first linear sensing means includes a first magnet means and first pole piece slidably engaged with the actuator to move linearly with the actuator.
3. The sensor of claim 1, wherein the second linear sensing means includes a second magnet means and second pole piece slidably engaged with the actuator to move linearly with the actuator.
4. The sensor of claim 1, wherein the first linear sensor has a first slide having a slot for slidably engaging the first linear sensor to the actuator.
5. The sensor of claim 1, wherein the second linear sensor has a second slide having a slot for slidably engaging the second linear sensor to the actuator.
6. The sensor of claim 1, wherein the first and second linear sensors can detect axial and rotational travel of the movable body.

7. The sensor of claim 2, wherein the first pole piece forms a U-shape where the first magnet means includes first and second magnets that are placed upon opposite legs of the first pole piece forming a gap between the first and second magnets.

8. The sensor of claim 7, wherein the first linear sensor includes a first Hall effect sensing element positioned within the gap to sense magnetic flux changes indicative of relative position of the body.

9. The sensor of claim 3, wherein the second pole piece forms an U-shape where the second magnet means includes third and fourth magnets placed upon opposite legs of the second pole piece forming a void between the third and fourth magnets.

10. The sensor of claim 9, wherein the second linear sensor includes a second Hall effect sensing element positioned within the void to sense magnetic flux changes indicative of relative position of the body.

11. The sensor of claim 6, wherein the movable body is a shifter that is coupled to the actuator using a ball and socket connection.

12. A sensor for determining the linear position of a movable body along two different axes, comprising:

- a) a housing being fixed in position against relative movement of a the body;
- b) an actuator, positioned in the housing and coupled to the movable body for receiving reciprocating motion;
- c) first linear sensing means, positioned within the housing and coupled to the actuator, for sensing the linear position of the actuator along a first axis wherein the first linear sensing means includes a first magnet means and first pole piece slidably engaged with the actuator to move with the linear position of the actuator;

- 11 d) second linear sensing means, positioned within the housing and coupled to
12 the actuator, for sensing the linear position of the actuator along a second
13 axis wherein the second linear sensing means includes a second magnet
14 means and second pole piece slidably engaged with the actuator to move
15 with the linear position of the actuator;
- 16 e) the first linear sensor having a first slide with a first slot thereon for slidably
17 engaging the first linear sensor to the actuator; and
- 18 f) the second linear sensor having a second slide with a second slot thereon for
19 slidably engaging the second linear sensor to the actuator.

13. The sensor of claim 12, wherein the first and second linear sensors can detect axial and rotational travel of the movable body that is coupled to the actuator.

14. The sensor of claim 13, wherein the movable body is a shifter that is coupled to the actuator.

15. The sensor of claim 12, wherein the first pole piece forms a U-shape, where the first magnet means includes first and second magnets that are placed upon opposite legs of the first pole piece forming a gap between therebetween.

16. The sensor of claim 15, wherein the first linear sensor includes a first Hall effect sensing element positioned within the gap to sense magnetic flux changes indicative of a relative position of the body.

17. The sensor of claim 12, wherein the second pole piece forms an U-shape where the second magnet means includes third and fourth magnets placed upon opposite legs of the second pole piece forming a void therebetween.

18. The sensor of claim 12, wherein the second linear sensor includes a second Hall effect sensing element positioned within the void to sense magnetic flux changes indicative of a relative position of the body.

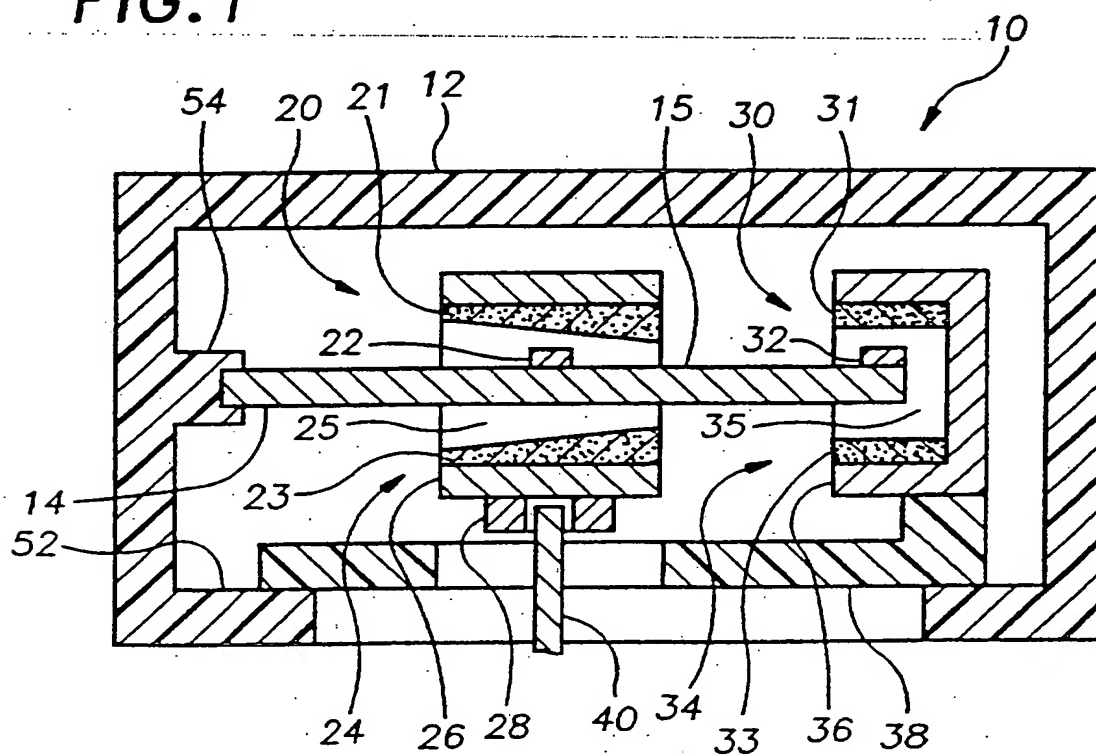
1 19. A sensor for determining the linear position of a movable body along two
2 different axes, comprising:

- 3 a) a housing being fixed in position against relative movement of a the body;
- 4 b) an actuator, positioned in the housing and coupled to the movable body for
5 receiving reciprocating motion;
- 6 c) first linear sensing means, positioned within the housing and coupled to the
7 actuator, for sensing the linear position of the actuator along a first axis
8 wherein the first linear sensing means includes a first magnet means and
9 first pole piece slidably engaged with the actuator to move with the linear
10 motion of the actuator;
- 11 d) second linear sensing means, positioned within the housing and coupled to
12 the actuator, for sensing the linear position of the actuator along a second
13 axis wherein the second linear sensing means includes a second magnet
14 means and second pole piece coupled to the actuator to move with the
15 linear motion of the actuator;
- 16 e) the first linear sensor having a first slide with a first slot thereon for slidably
17 engaging the first linear sensor to the actuator;
- 18 f) the second linear sensor having a second slide with a second slot for slidably
19 engaging the second linear sensor to the actuator;
- 20 g) the first and second linear sensors having the ability to detect axial and
21 rotational travel of the movable body that is coupled to the actuator, and
22 the movable body is a shifter that is coupled to the actuator;
- 23 h) the first pole piece forming a U-shape, where the first magnet means includes
24 first and second magnets that are placed upon opposite legs of the first
25 pole piece forming a gap therebetween;
- 26 i) the first linear sensor including a first Hall effect sensing element positioned
27 within the gap to sense magnetic flux changes indicative of a relative

- 28 position of the body;
- 29 j) the second pole piece forming an U-shape, where the second magnet means
- 30 includes third and fourth magnets placed upon opposite legs of the second
- 31 pole piece forming a void therebetween; and
- 32 k) the second linear sensor including a second Hall effect element positioned
- 33 within the void to sense magnetic flux changes indicative of a relative
- 34 position of the body.
-

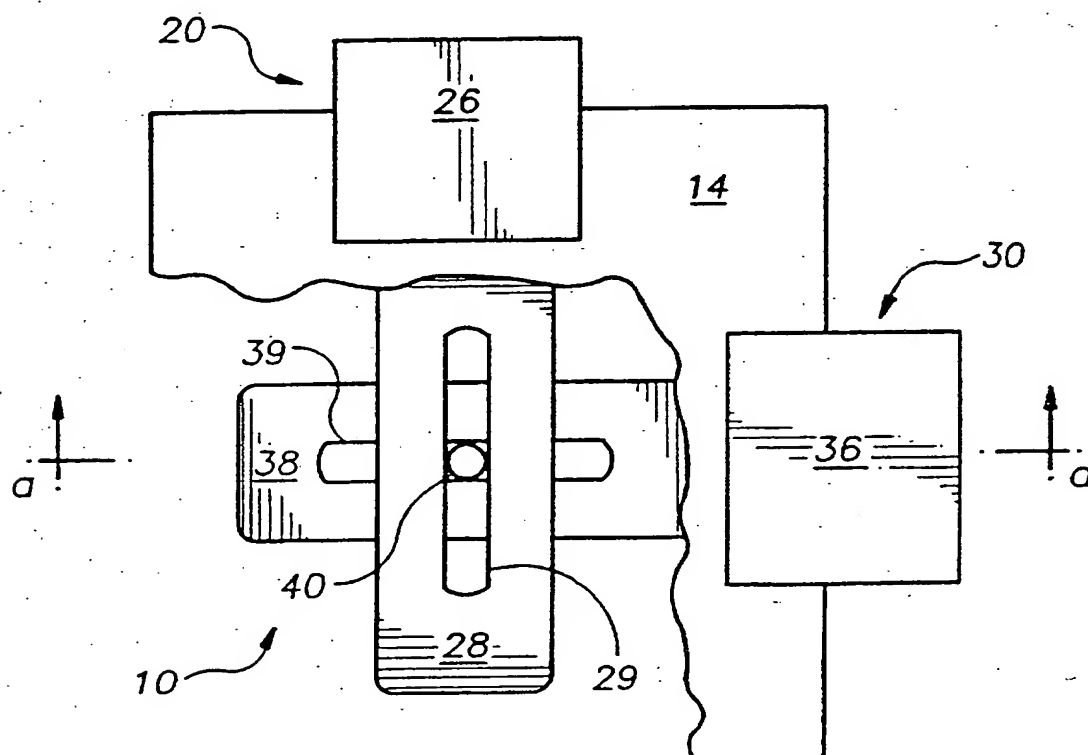
1/4

FIG. 1



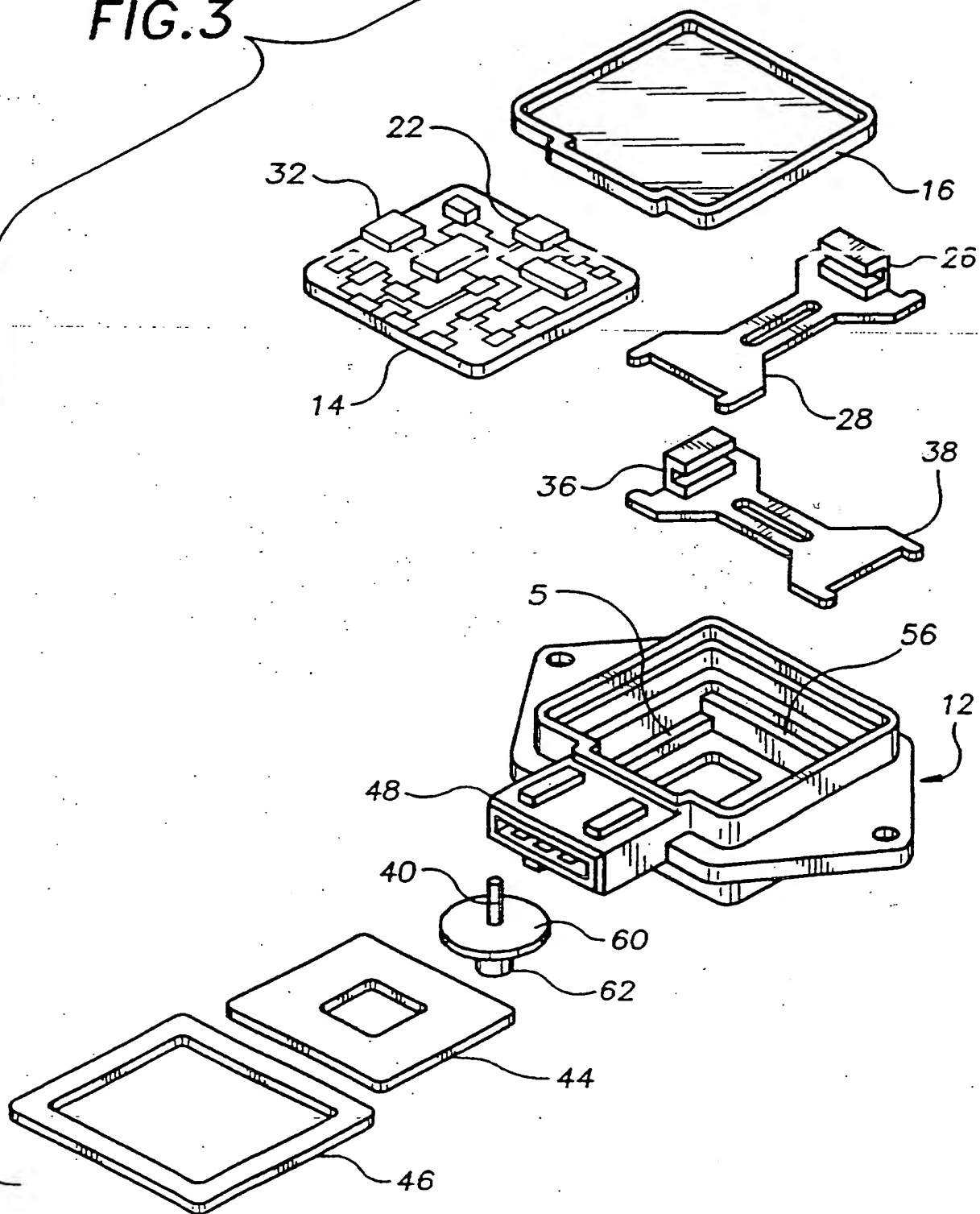
2/4

FIG. 2



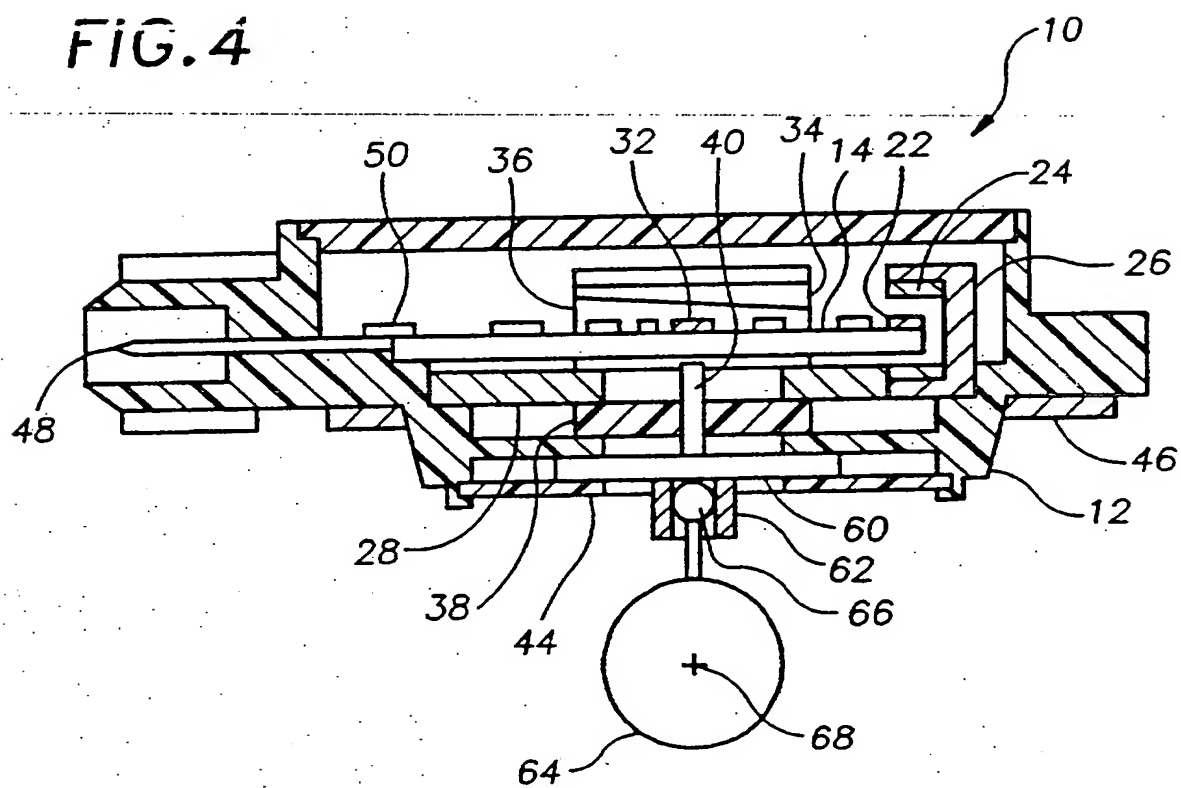
3/4

FIG. 3



4/4

FIG. 4

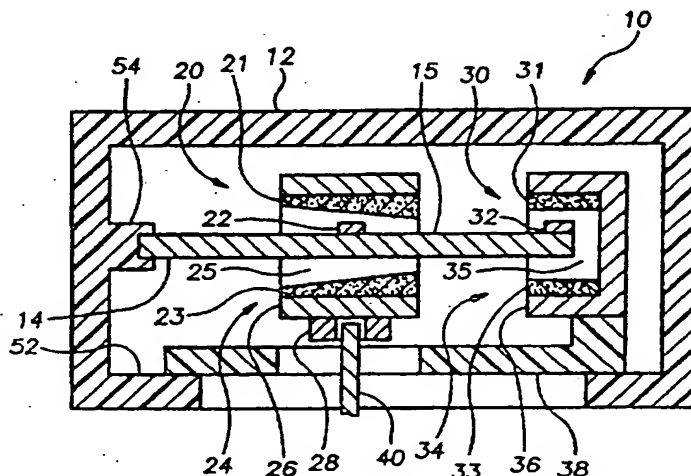




INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁶ : G01B 7/14		A3	(11) International Publication Number: WO 97/16736
			(43) International Publication Date: 9 May 1997 (09.05.97)
(21) International Application Number: PCT/US96/17255		(81) Designated States: AU, BR, CA, JP, MX, US, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).	
(22) International Filing Date: 18 October 1996 (18.10.96)			
(30) Priority Data: 60/005,770 20 October 1995 (20.10.95) US		Published <i>With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i>	
(71) Applicant (for all designated States except US): CTS CORPORATION [US/US]; Mr. Michael W. Starkweather, 905 West Boulevard North, Elkhart, IN 46514 (US).		(88) Date of publication of the international search report: 10 July 1997 (10.07.97)	
(72) Inventors; and (75) Inventors/Applicants (for US only): OLSON, Thomas, R. [US/US]; 1198 N 450 E, Chesterton, IN 46304 (US). SHRIVER, Bret, W. [US/US]; 5401 Osage Lake Drive #3-B, Mishawaka, IN 46545 (US). ZDANYIS, John, Jr. [US/US]; 26819 Bridgewater Court, Elkhart, IN 46514 (US). NONNENMACHER, Ronald, C. [US/US]; 1617 Locust #203, Elkhart, IN 46514 (US). JARRARD, Craig, A. [US/US]; 611 Spring Arbor Drive, Middlebury, IN 46540 (US). WHITE, James, E. [US/US]; 1721 Sunfish Drive, Warsaw, IN 46580 (US). McCURLEY, Jeffrey, L. [US/US]; 70052 Arbola Drive, White Pigeon, MI 49099 (US).			
(74) Agent: STARKWEATHER, Michael, W.; CTS Corporation, 905 West Boulevard North, Elkhart, IN 46514 (US).			

(54) Title: A TWO AXES LINEAR POSITION SENSOR



(57) Abstract

A dual-axes position sensor (10) having an outer housing (12), an actuator (40), two Hall effect sensor assemblies (20, 30) for detecting changes along a first (y) and second (x) axis is disclosed. The housing (12) is made of a non-magnetic material. The actuator (40) is rod shaped and coupled to a movable device. The Hall sensor assembly (20) is set on a lip (52) of the housing (12) and includes a pole piece (26) and a magnet assembly (24) having an upper and lower magnet (21, 23) separated by an air gap (25). The two Hall sensor assemblies (20, 30) are positioned 90 degrees from each other.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AM	Armenia	GB	United Kingdom	MW	Malawi
AT	Austria	GE	Georgia	MX	Mexico
AU	Australia	GN	Guinea	NE	Niger
BB	Barbados	GR	Greece	NL	Netherlands
BE	Belgium	HU	Hungary	NO	Norway
BF	Burkina Faso	IE	Ireland	NZ	New Zealand
BG	Bulgaria	IT	Italy	PL	Poland
BJ	Benin	JP	Japan	PT	Portugal
BR	Brazil	KE	Kenya	RO	Romania
BY	Belarus	KG	Kyrgyzstan	RU	Russian Federation
CA	Canada	KP	Democratic People's Republic of Korea	SD	Sudan
CF	Central African Republic	KR	Republic of Korea	SE	Sweden
CG	Congo	KZ	Kazakhstan	SG	Singapore
CH	Switzerland	LI	Liechtenstein	SI	Slovenia
CI	Côte d'Ivoire	LK	Sri Lanka	SK	Slovakia
CM	Cameroon	LR	Liberia	SN	Senegal
CN	China	LT	Lithuania	SZ	Swaziland
CS	Czechoslovakia	LU	Luxembourg	TD	Chad
CZ	Czech Republic	LV	Latvia	TG	Togo
DE	Germany	MC	Monaco	TJ	Tajikistan
DK	Denmark	MD	Republic of Moldova	TT	Trinidad and Tobago
EE	Estonia	MG	Madagascar	UA	Ukraine
ES	Spain	ML	Mali	UG	Uganda
FI	Finland	MN	Mongolia	US	United States of America
FR	France	MR	Mauritania	UZ	Uzbekistan
GA	Gabon			VN	Viet Nam

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US96/17255

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :G01B 7/14

US CL :324/207.2

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 324/207.2,207.22,207.23,235,251;74/471XY;338/32H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
NONE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 3,421,227 A(TURNER et al.) 14 JANUARY 1969, col. 1,lines 26-70	1-19
A	US 4,639,667 A(ANDRESEN) 27 JANUARY 1987, Abstract	1-19



Further documents are listed in the continuation of Box C.



See patent family annex.

- * Special categories of cited documents:
- *A* document defining the general state of the art which is not considered to be of particular relevance
- *E* earlier document published on or after the international filing date
- *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- *O* document referring to an oral disclosure, use, exhibition or other means
- *P* document published prior to the international filing date but later than the priority date claimed

- *T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- *X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- *Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- *Z* document member of the same patent family

Date of the actual completion of the international search

13 DECEMBER 1996

Date of mailing of the international search report

07 MAY 1997

Name and mailing address of the ISA/US
Commissioner of Patents and Trademarks
Box PCT
Washington, D.C. 20231

Facsimile No. (703) 305-3230

Authorized officer

WALTER E. SNOW

Telephone No. (703) 305-4700